Scientific Motivation

- Nucleosynthesis, Chemical Evolution, Galaxy Evolution, Stellar Evolution.
- Galactic archaeology and galaxy evolution through detailed analysis of stars in the Galaxy and Local Group galaxies.
- Detailed chemical abundance analysis of stars throughout the Galaxy, including obscured regions, such as the galactic bulge, large distances within the disk and streams from accreted satellites.

- Chemical abundances and ages, as a function of [Fe/H] for stars in all galaxies of the Local group.
- Details such as alpha, s-process and r-process ratios important for determining formation timescales, IMF, and inflow or outflow of gas during their evolution.
- Simultaneously solve the problems of nucleosynthesis, chemical evolution and galaxy evolution.
- Ideally would like to go beyond LG (e.g. globular cluster integrated-light).

8m-Class Instruments

- (1) High Resolution, broad-band, near infrared spectrograph, with R~50,000.
  - »
- (2) AO imager that also feeds a moderate resolution spectrograph, with R~10,000.
- (3) High resolution, high throughput, optical spectrograph for use on Gemini with multi-object capability. R~50,000, ~10-100 objects, broad-band.
- Support for Wide-Field Hi-Res Capability of WFMOS

(1) Hi-Res IR Spectroscopy: Science Case

- Star formation histories of stellar populations using light elements (Mg, Na, Si, Ca)
  - Bulge
  - Merger remnants
  - Disk populations
  - Nearby local group galaxies
- Important follow up to Sloan/SEGUE discoveries
- Light element abundances are sensitive diagnostics of population differences and star formation histories

Implementation Paths

- Near-term
  - Phoenix @ SOAR
    - Limiting magnitude linear with aperture
    - Clouds, Bulge, Globulars
    - Young stellar populations in the disk
  - NIRSPEC (Keck) detector upgrade as part of TSIP
- Longer term
  - HRNIRS Lite (R = 50000 / multi-object TBD)
  - Less evolved stars in the Clouds, Bulge
  - Sampling Andromeda?

(2) Stellar Populations & Adaptive Optics Capabilities

- Technological advances in laser-guide-star adaptive optics enable opportunities in stellar populations of nearby galaxies

- Target galaxies with distance~M31 and somewhat more
  - M31 is most prominent target
  - Also dwarfs & streams at similar distances

- Enables detailed study of stellar populations and chemical evolution in environment other than Milky Way

- Imaging at HST or better resolution yields color-magnitude diagrams

  - Field of 1-2 arcmin
  - Color baseline from R to K
  - Redder wavelengths diminish effects of extinction

Stellar Populations & Adaptive Optics Capabilities

- HST imaging & resulting CMDs revolutionized stellar populations
  - HST won't be around too much longer
- Multi-object AO-enhanced spectroscopy
  - R = 10,000
  - Yields abundances and radial velocities
    - Need alpha to iron ratios
  - Multiplex advantage is important
    - Likely need deployable IFUs
  - Spatial resolution is critical due to crowding

(3) Hi-Res, high through-put Optical Spectrograph. Local Group and Beyond

- Detailed chemical abundance studies of stars in nearby Local Group members is possible; although not with bHROS. bHROS is 100 times less efficient than the Magellan MIKE spectrograph.

- Currently the only access available to US public observers is through Keck and Magellan echelle spectrographs. This represents a significant lacuna in the capabilities of the national facilities.

Distant Local Group

- For more distant Local Group galaxies extant telescope apertures are insufficient for single object methods of high resolution abundance analysis.
- The solution is to employ stacking of many spectra obtained simultaneously.
- Need high-resolution MOS mode. Also desired for maximum efficiency of closer targets.

..and Beyond

- High resolution integrated-light abundances of globular clusters. MOS mode effective here.

The Need for Wide Field High-Resolution Optical Spectroscopic Capability on 8m Telescopes

- Knowledge of the origin and evolution of the elements, in particular those beyond the light (CNO) and alpha elements, can only come from high-resolution spectroscopy.

- Obtaining such data for significantly large numbers of stars, with low areal density on the sky (i.e., the MW halo, thick disk, anti-center) can only come from wide-field multi-object spectrographs.

- Provides the opportunity for measurement of N = 20-30 elemental species per star, for well-selected (based on previous medium-res, and/or photometric surveys), well-understood samples.

The Need -- Continued

- Provides data needed to constrain absolute frequencies of elemental abundance patterns in stars. For instance, frequency of alpha-rich, alpha-poor, n-capture rich, c-rich stars, etc., which in turn strongly constrain all models of early generation star formation.

- This knowledge will form the baseline for all models of Galactic Chemical Evolution now and in the future.

- Provides entry to possible (likely) collaboration with other areas of research (e.g., Nuclear Astrophysics) that have great interest in “laboratories” for constraining origins of the elements.

Implementation Path -- WFMOS

- Opportunities for establishing and developing relationships with the Japanese astronomy community through cost/time share between Gemini and Subaru.

- Strong support for pursuit of the WFMOS concept, and rapid implementation of design (assuming satisfactory).